Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

William R. Lagergren, Jr
Site Vice President, Watts Bar Nuclear Plant

SEP 1 1 2002

U.S. Nuclear Regulatory Commission 10 CFR 50.73
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

TENNESSEE VALLEY AUTHORITY - WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - DOCKET NO. 50-390 - FACILITY OPERATING LICENSE NPF-90 - LICENSEE EVENT REPORT (LER) 50-390/2002-003

The enclosed report provides details of an automatic turbine/reactor trip which occurred on July 13, 2002. This event resulted from actuation of a Main Transformer differential relay due to a grounded conductor (splice) for a current transformer. The plant trip and subsequent actuation of an engineered safety feature is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A).

If you should have any questions, please call P. L. Pace at (423) 365-1824.

Sincerely,

W.R. Lagergren

W. R. Lagergren

Enclosure
cc (Enclosure):

IE22

SEP 1 1 2002

cc (Enclosures):

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NRC FORM 366 (7-2001)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 7/31/2004
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)		Estimated burden per response to comply with this mandatory information collection request 50 hrs Reported lessons learned are incorporated into the licensing process and fed back to industry Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U S Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc gov, and to Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget Washington DC 20503 If a means used to impose information collection does not display a currently valid OMB control number , the NRC may not conduct or sponsor, and a person is not required to respond to the

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4. TITLE

Automatic Turbine/Reactor Trip Due To Main Transformer Protection Circuit Ground Due To Inadequate Cable Splice

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									NA	05000
07	13	2002	2002	-- 003 --	00	09	11	2002	FACILITY NAME NA	DOCKET NUMBER 05000

9. OPERATING MODE	1
10. POWER LEVEL	100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: (Check one or more)

	20.2201(b)		20.2203(a)(3)(ii)		50 73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)	X	50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50 36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER (Voluntary)
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50 73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50 73(a)(2)(viii)(A)		
	20 2203(a)(3)(i)		50 73(a)(2)(ii)(A)		50 73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Charles Touchstone, Licensing Engineer	(423) 365-3820

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED			15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

Abstract (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On July 13, 2002, at approximately 1622 EDT, while the plant was in Mode 1, at 100% power, Watts Bar Unit 1 experienced an automatic turbine/reactor trip when a C-Phase Main Transformer differential relay actuated This occurred because a bolted cable splice associated with a C-phase current transformer (CT) came into contact with the CT junction box; thereby shorting the differential relay protection circuit to ground. The apparent factors contributing to this short circuit condition include temperature, cable splice material, vibration, and configuration of the splice inside the junction box.

All control rods inserted properly in response to the reactor trip. The Auxiliary Feedwater (AFW) System actuated in response to the trip, as designed. Plant response was in accordance with design with no complications. Operations shift personnel performance was in accordance with applicable procedures.

Subject to confirmatory laboratory testing, the root cause of this event was determined to be inadequate work instructions that allowed lower temperature rated tape to be used on a cable replacement and/or inadequate application of splice material. Corrective actions include revision and training on TVA's engineering and maintenance procedures for high temperature jacketing material, laboratory analysis of damaged splices, and reinspection and taping of similar vulnerable cable splices.

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I. PLANT CONDITION(S)

Watts Bar Unit 1 was in power operation at approximately 100 percent reactor power

II. DESCRIPTION OF EVENT

A. Event:

While operating at 100% power, Watts Bar Unit 1 experienced an automatic turbine/reactor trip at 1622:24 EDT on July 13, 2002, when a C-Phase Main Transformer differential relay (Energy Industry Identification System (EIIS) code 87) actuated. This occurred because the metal portion of a bolted splice associated with a C-phase current transformer (CT, EIIS code XCT) came into contact with the CT junction box; thereby shorting the differential relay protection circuit to ground causing actuation of the main transformer protection function. The apparent factors contributing to this short circuit condition include temperature, cable splice material, vibration, and configuration of the splice inside the junction box. Problem Evaluation Report (PER) 02-009532-000 was initiated to document this event in the TVA Corrective Action Program.

All control rods inserted properly in response to the reactor trip. The Auxiliary Feedwater (AFW) System (EIIS code BA) actuated in response to the trip, as designed.

During the February/March 2002 refueling outage for Watts Bar Unit 1, the Main Generator bushing box was disassembled to repair hydrogen leaks identified at the end of the previous refueling outage. While performing this activity, installed cables from the manufacturer's junction box to the related current transformers were observed to be damaged, apparently due to heat. The installed cabling was rated for 75 degrees C (167 degrees F). A Work Order (WO) was initiated to replace the damaged cable sections with higher temperature rated cables (250 degrees C/482 degrees F). The WO specified bolted splices configured with Scotch 70 tape as an insulating material and Scotch 33+ tape as a jacketing material. It was not recognized that the temperature rating of the Scotch 33+ tape was questionable for the operating environmental conditions within the junction box. As is typical in cable installation, sufficient pigtail and field cable lengths were retained to facilitate any future re-splicing. In order to store this excess length of cable inside the junction box, it was necessary to train (coil) the cable 180 degrees from entry to the junction box. The as-left configuration of the splice involved in this event had its tip (bolted end) lying against a wall of the junction box at approximately a 45 degree angle, and under some pressure. The applicable TVA Engineering Specification G-38 requires that cables be supported so there is no mechanical load on the splice. On July 13, 2002, after about four months of full power operation, a fault occurred at the point where the splice was resting against the junction box wall. After re-taping the splice and installing tie wraps to minimize contact with the junction box wall, the plant was restarted and returned to full power operation.

The purpose of Scotch 33+ tape is to provide mechanical protection for the Scotch 70 tape. Scotch 70 tape is a high temperature insulating material. Per G-38, 90 degrees C (194 degrees F) is the temperature rating of Scotch 33+ tape, a PVC tape (thermoplastic material). Based on 3M tape

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vendor documentation, the actual rating of Scotch 33+ tape is 105 degrees C (220 degrees F). Nevertheless, this type of material will gradually soften at elevated temperatures. G-38 and plant instructions do not permit the use of tape where environmental temperatures exceed the tape temperature rating, however, the effect of the operating temperatures on the tape was not realized at the time of the cable replacement and the immediate repairs after the trip. Therefore, during the event investigation, and after attaining normal full power conditions, thermocouples and infrared thermography were used to measure temperatures at this and related junction boxes. The highest recorded ambient temperature was 210 degrees F. Even though the temperature rating of 220 degrees F was not exceeded, the temperature rating for Scotch 33+ tape is considered the most significant contributing factor in this event. In other words, the use of this tape marginally within its maximum temperature limit, may not in itself always result in a fault. However, as a result of other environmental conditions, the conductor portion of the splice shorted to the junction box. Once the protective cover provided by the Scotch 33+ tape was degraded (softened at higher temperature), the Scotch 70 tape became susceptible to cut-through by the lugging material, given the vibration and the physical loading. Since the actual splice was not removed for analysis (an issue being addressed separately), it will be removed at the next available opportunity and sent for laboratory analysis to validate the above assumptions.

B. Inoperable Structures, Components, or Systems that Contributed to the Event:

There were no structures, components, or systems inoperable at the start of the event that contributed to the event.

C. Dates and Approximate Times of Major Occurrences:

DATE	ACTION
1/14/1999	Engineering issues generic substitution data sheet (GSDS) for high temperature cable based on Design Change EDC 50105.
2/28/2002	Maintenance identifies cable damage due to high temperature environment.
2/28/2002	Actual operating temperature is unknown.
2/28/2002	Maintenance initiates PER 02-002480 to document condition.
2/28/2002	Maintenance initiates WO 02-002582-000 to replace cable.
3/12/2002	Cable is replaced with high temperature cable.
3/12/2002	Cables are spliced with Scotch 70 and Scotch 33+ as jacketing material.
7/13/2002	Cable splice fails causing spurious operation of the generator differential relay.
7/13/2002	Turbine trip/reactor trip. (1622 EDT)

D. Other Systems or Secondary Functions Affected:

There were no other plant systems or secondary functions directly affected by the subject event.

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E. **Method of Discovery:**

The turbine/reactor trip was an automatic response to actuation of the C-Phase Main Transformer differential relay protection circuit.

F. **Operator Actions:**

Operations personnel correctly responded to the reactor trip in accordance with Emergency Procedure E-0, "Reactor Trip or Safety Injection." The involved personnel transitioned when required into the appropriate emergency and abnormal procedures to properly stabilize the unit in Mode 3.

G. **Safety System Responses:**

The Watts Bar Unit 1 reactor automatically tripped following a turbine trip caused by actuation of the C-Phase Main Transformer differential relay. All control rods inserted properly and the Auxiliary Feedwater (AFW) System started, as required, in response to the reactor trip. The AFW system was the only engineered safety feature (ESF) equipment required to respond to this event. The AFW System was subsequently placed in manual control by procedure to reduce feedwater flow to control plant cooldown.

III. CAUSE OF THE EVENT

A. **Immediate Cause:**

The automatic turbine/reactor trip resulted from actuation of a C-Phase Main Transformer differential relay protection circuit. The metal portion of a bolted cable splice associated with the C-phase current transformer (CT) came into contact with the CT junction box; thereby shorting the differential protection relay circuit to ground causing actuation of the differential relay. The direct cause of the equipment failure was determined to be a combination of several factors. These factors are temperature, cable splice material (Scotch 33+), vibration, and configuration of the splice inside the junction box adjacent to the main generator current transformer.

B. **Root Cause:**

Subject to confirmatory laboratory testing, the root cause of this event was determined to be inadequate work instructions that allowed lower temperature rated tape to be used on a cable replacement splice because the operating environmental conditions within the junction box were unknown, and/or inadequate application of splice material. Because conclusive information was not collected during the post-trip recovery activities, the root cause of this event cannot be verified until an outage occurs that permits additional inspection of the affected junction box.

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C. Contributing Factor:

There was no contributing factor for this event.

IV. ASSESSMENT OF SAFETY CONSEQUENCES

The plant experienced a loss of load event. The main generator's C phase main transformer differential relay tripped. This resulted in a turbine trip. A direct reactor trip occurred as a result of the turbine trip. The main condenser steam dump valves opened per design to accommodate the excess steam generation and the pressurizer pressure control system functioned properly. As a result, reactor coolant temperature and pressure did not increase significantly.

This event is compared to the "Loss of External Load and/or Turbine Trip" event (Ref: FSAR Section 15.2.7). The complete loss of load/turbine trip from full power is examined primarily to show the adequacy of the pressure relieving devices and also to demonstrate that the Reactor Protection System (RPS, EIIS code JG) provides protection against departure from nucleate boiling (DNB). The design and licensing basis analysis does not credit operation of the steam dump system or steam generator power-operated relief valves (PORVs). The sudden reduction in steam flow results in an increase in pressure and temperature in the steam generator shell. As a result, the heat transfer rate in the steam generator is reduced, causing the reactor coolant temperature to rise, which causes coolant expansion, pressurizer insurge, and Reactor Coolant System (RCS, EIIS code AB) pressure rise. Unless the transient RCS response to the loss of external electrical load and/or turbine trip event is terminated by manual or automatic action, the resultant reactor coolant temperature rise could eventually result in DNB and/or a challenge to the integrity of the Reactor Coolant Pressure Boundary (RCPB) or the Main Steam System Pressure Boundary. To avert the possible damage that might otherwise result from this event, the RPS is designed to automatically terminate any such transient before the DNB ratio (DNBR) falls below the safety analysis limit value and before the peak pressures exceed the values at which the integrity of the pressure boundaries would be jeopardized.

Unlike the design and licensing basis analysis, in the actual event, the main condenser steam dump valves opened per design and the pressurizer pressure control system functioned properly. As a result it was not necessary for the steam generator PORVs to operate. Pressurizer level did not increase and pressurizer pressure did not increase in a manner that would challenge the pressurizer PORVs or safety valves. Also in the actual event, RCS temperature did not rise; but rather dropped to an average temperature of 559 degrees F. Since a direct reactor trip occurred as a result of the turbine trip, it was not necessary for the RPS to initiate a reactor trip by the RPS trip signals of OTΔT, High Pressurizer Pressure, High Pressurizer Water Level, or Low-Low Steam Generator Water Level. Therefore the DNB safety analysis limit value was never challenged.

In summary, the FSAR critical parameter plots of pressurizer pressure, pressurizer water volume, RCS inlet and average temperature, and steam generator pressure bound the values that actually occurred during the actual event. DNBR was never challenged during the event because no increasing RCS temperature excursions occurred. Therefore, the actual plant response for this event falls within the bounds of the design basis response.

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V. CORRECTIVE ACTIONS

A. Immediate Corrective Actions:

Work Order W0 02-009536-000 was initiated to perform troubleshooting. Based on troubleshooting, 3 cable splices were taped over, damaged cable was repaired using Scotch 70 and 33+, and a protective material was placed where the cables enter the junction boxes. Additionally the cables splices were wrapped to minimize contact with the junction box walls.

The extent of condition was determined to be limited to 13 cables that contain a splice in the same environment that caused the initial cable damage. These cables, including the damaged cable/splice (Cable 1G20), are all associated with the generator CTs. The corrective actions discussed above for the troubleshooting WO 02-009536-000 include these 13 cables/splices. At the time of repair, it was not recognized that the lower temperature rated tape was potentially inappropriate for the environmental conditions within the junction box. However, the corrective actions performed should provide sufficient protection to prevent the reoccurrence of a cable/splice fault as an interim measure. Longer-term corrective actions for the splices are discussed in Section V.B.

B. Corrective Actions to Prevent Recurrence:

The following actions are tracked under TVA's corrective action program and therefore, are not considered to be regulatory commitments:

1. Issued exception to G-38 to allow the use of high temperature jacketing tape (Scotch 69) in turbine building areas at WBN.

2. Provided a Lessons Learned meeting with personnel responsible for splicing cables on the root causes of this event.

3. Revise GSDS 3087 to require use of the high temperature jacketing material.

4. Revise General Engineering Specification G-38 to provide for a high temperature jacketing material to use on splices located in high temperature environments.

5. Revise and conduct training on applicable Maintenance Instructions to include the use of Scotch 70 and the high temperature jacketing material required by G-38.

6. Inspect/Re-work splices identified by the extent of condition with new high temperature jacketing material. All splices associated with this event must be preserved for further analysis. This action will be completed the next time the generator is offline.

7. Send cable splices (identified in CA-6) that were identified as damaged to the Central Laboratory for testing to determine the cause of the splice damage.

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VI. ADDITIONAL INFORMATION

A. Failed Components:

There were no additional failed components from those discussed above.

B. Previous LERs on Similar Events:

A review was performed of previous WBN LERs for any similar events. WBN has not experienced any prior turbine/reactor trips due to ground faults involving cable/splice problems. A previous similar plant trip occurred during 1997 when the main generator circuit breaker opened due to problems with the A phase main transformer high side potential device. However, since no anomalies have been identified with the plant response to the current event, no further comparison of these events is necessary.

C. Additional Information:

None

D. Safety System Functional Failure Consideration:

The subject cable/splice failure is not safety significant. The 13 cables discussed in Section V.A are not safety related. Therefore, this event does not constitute a safety system functional failure in accordance with NEI 99-02

E. Loss Of Normal Heat Removal Consideration:

This event did not result in loss of normal heat removal capability.

VII. COMMITMENTS

None